FLORIDA WATER RESOURCE MANAGEMENT

DEVELOP

MONITORING INVASIVE AQUATIC VEGETATION IN LAKE OKEECHOBEE, FLORIDA, USING NDVI DERIVED FROM MODIS DATA

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INTRODUCTION

- Lake Okeechobee is approximately 1,700 km^2 in size with a drainage basin covering 12,000 km^2 (*Flaig and Reddy*, 1995; *Philips et al.*, 1995)
- The lake provides drinking water for several small towns in central and southern Florida (*Earthjustice*, 2006) and is also host to recreational activities
- High phosphorus levels caused by agricultural run-off have threatened the lifespan of the lake by increasing the rate at which algal species and aquatic vegetation multiply (*Mackool*, 2007)
- Excessive vegetative growth is both aesthetically displeasing and harmful to the human environment and surrounding ecology
- Uncontrolled algae growth can lead to dense vegetative mats on the water's surface that deplete resources for native organisms

INVASIVE SPECIES OF CONCERN


Cyanobacteria


Water Hyacinth


Hydrilla

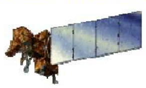

Water Lettuce

RESEARCH GOALS

- Apply MODIS data to water resource and water quality management
- Use NDVI to monitor aquatic, rather than terrestrial, vegetation
- Show growth and movement of invasive aquatic vegetation spatially and temporally

NASA / NASA PARTNERED MISSIONS


Terra Mission


Landsat 7 Mission

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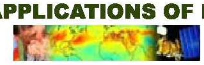
NASA PARTNER DATA SOURCES

US Army Corps of Engineers

APPLICATIONS OF NATIONAL PRIORITY


Water Resources

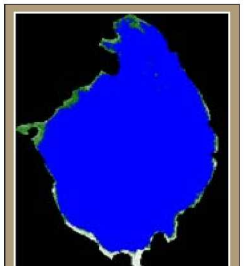

Public Health

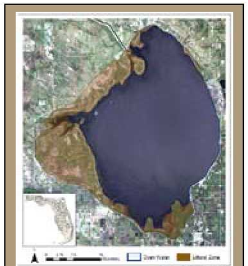
ABSTRACT

Lake Okeechobee, located in southern Florida, encompasses approximately 1,700 km^2 and is a vital part of the Lake Okeechobee and Everglades ecosystem. Major cyanobacterial blooms have been documented in Lake Okeechobee since the 1970s and have continued to plague the ecosystem. Similarly, hydrilla, water hyacinth, and water lettuce have been documented in the lake and continue to threaten the ecosystem by their rapid growth. This study examines invasive aquatic vegetation occurrence through the use of the Normalized Difference Vegetation Index (NDVI) calculated on MOD09 surface reflectance imagery. Occurrence during 2008 was analyzed using the Time Series Product Tool (TSPT), a MATLAB-based program developed at John C. Stennis Space Center. This project tracked spatial and temporal variability of cyanobacterial blooms, and overgrowth of water lettuce, water hyacinth, and hydrilla. In addition, this study presents an application of Moderate Resolution Imaging Spectroradiometer (MODIS) data to assist in water quality management.

METHODS

- Acquired MOD09 daily surface reflectance imagery from 1 May 2008 to 1 October 2008
- Processed raw images using TPST, which performed the following operations:
  - **Projection:** all images set to UTM WGS84 Zone 17N
  - **NDVI:** calculated NDVI on each image
  - **Clear:** removed pixels with cloud cover and shadow
  - **Maxvza:** removed pixels with view zenith angle ≥50°
  - **Fuse:** combined MOD09QK (original surface reflectance) and MOD09GA (includes observation data and geolocation statistics) data
  - **Outlier:** removed NDVI values outside of set thresholds
  - **Time:** replaced missing pixel values using temporal interpolation
- Stacked processed images into a single image with 116 layers in ERDAS IMAGINE©
- Color-coded each layer to show areas of suspected aquatic vegetation, which included NDVI values >0.2 and <1, with all other values suspected to be water
- Used a STACK MAX model to show total maximum NDVI values for all five months and for each month individually
- Compared visual results with U.S. Army Corps of Engineers spray treatment data


MOD09 color-coded image from August 25, 2008. Dark green indicates low NDVI values and white indicates higher NDVI values.


Map showing project study area. Research focused on the open water region of Lake Okeechobee.

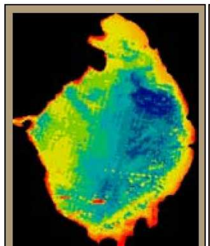
	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Total
5010				27	0	27
5020	86.5		8.5	77.5	43	215.5
5030	104	67	69.5	17	35	292.5
5040				81	289	370
Total	190.5	67	78	202.5	367	895

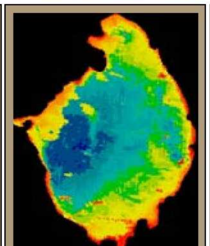
Acres treated by spray zone for May to September 2008 (*USACE*, 2009).

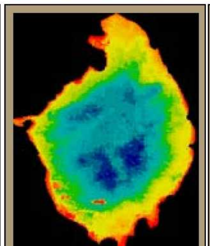
RESULTS

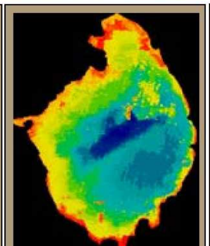
Maximum NDVI Values by Month

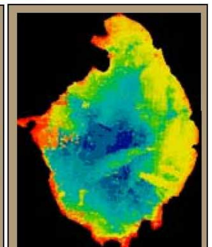
Low High


May 2008

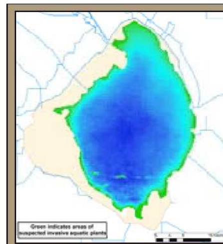

June 2008


July 2008

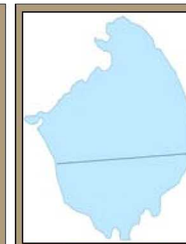

August 2008

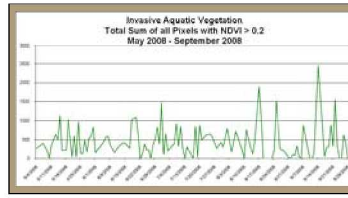

September 2008

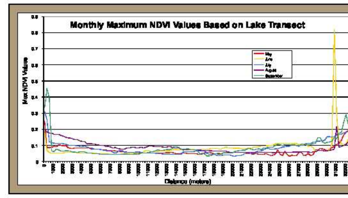
RESULTS CONTINUED



Suspected floating vegetation based on sum of pixels with NDVI values greater than 0.2 from May to September 2008.


Transect line based on area of interest spanning the entire lake used for each monthly maximum NDVI image.





CONCLUSIONS

- NDVI values can be calculated from MODIS-derived products and applied to aquatic vegetation
- Spatial and temporal change can be deduced from time analysis assessment
- Individual images should be correlated against meteorological and nutrient level in-situ data; however, current data is limited
- Temporal analysis of NDVI values could be conducted to assess impacts of sugarcane harvesting (to the south) and cattle farming (to the north) on nutrient levels in the lake
- The time period could be broadened to gain an understanding of long-term NDVI changes associated with land use change

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